The urticating apparatus in the larva of the Lappet Moth, *Streblote panda* Hübner, 1820 (Lepidoptera: Lasiocampidae)

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Abstract. A morphological study of the urticating apparatus in the last larval instar of *Streblote panda* Hübner, 1820 (Lepidoptera: Lasiocampidae) was undertaken using a scanning electron microscope. It is composed of two meso- and metathoracic crevices, accompanied by urticating hairs, which open when the caterpillar is threatened. The urticating hairs taper at both ends and are mostly smooth but ringed on their distal part, which also features about 400 pores allowing the urticating liquid to be released.

Key words. Lasiocampidae, *Streblote panda*, scanning electron microscopy, urticating hairs.

INTRODUCTION

The Lappet Moth *Streblote panda* Hübner, 1820 (Lasiocampidae: Lasiocampinae) is distributed in Spain and North Africa. In Morocco, it is a common species on the plains and lower mountains of the Atlantic coast, the region of Souss (Southwestern Morocco) and the Western and Central High Atlas (Rungs 1981) where adults are active in January, June–July and October. *Streblote panda* is an eremic species that prefers littoral, sandy and open scrub areas (Calvo & Molina 2008). The caterpillars are highly polyphagous, feeding on the leaves of different plants from a broad spectrum of plant families such as Fagaceae, Euphorbiaceae, Myrtaceae, Fabaceae, Rosaceae, Salicaceae, Sapindaceae, Rutaceae and Tamaricaceae (Freina & Witt 1987). In Western Andalusia, it infests several perennial plants of ornamental and economic interest such as the Blueberry (*Vaccinium* sp., Ericaceae; Calvo & Molina, 2004). It has been considered a local pest for lime and grapefruit and its larvae may also have an unwanted effect in nurseries when they feed on young growing plants (Molina 1998).

The caterpillar of *S. panda* is known for its urticating properties. The urticating apparatus has not been studied in detail so far; Calvo & Molina (2008) simply mention that urticating retractable organs develop beginning from the second instar and appear as mere cuticle differentiations in the first instar. In the present study, details of the morphological structures responsible for the urticating properties are provided for the first time.

MATERIALS AND METHODS

Larvae of *Streblote panda* were captured at the Atlantic coast of Morocco at Essaouira in August 2005 and Oualidia in November 2008 on the foliage of *Retama monosperma* (Linné) Boissieu (Fabaceae). Their larval development comprises 5–8 instars (Calvo & Molina 2005). Only the last instar larvae have been collected and studied. For observation with scanning electron microscopy (SEM), the mesonotum and metanotum were dissected and isolated, dehydrated in absolute ethanol, mounted on specimen holders and coated with a thin layer of gold and palladium in a Jeol JFC-1100 sputter coater. Preparations were examined in a Jeol JSM-6400 SEM at 7 kV.

RESULTS

The urticating retractable apparatus is composed of two sets of hairs located on the dorsal surface of the mesothoracic and metathoracic segments (Fig. 1). In each segment, more than a thousand of these hairs are inserted in the internal walls of an integumentary fold composing a deep, crescent-shaped crevice. At rest, the latter is retracted and reveals externally only a transverse line whose edges are lined with a few hairs. When active, the pocket opens, revealing and spreading all the hairs it contains (Fig. 1). A single type of urticating hair has been observed. It is spear-shaped, 0.65–1.10 mm long (Fig. 5), with a slender base (Fig. 6) and pointed distally (Fig. 7). It is delicately stri-

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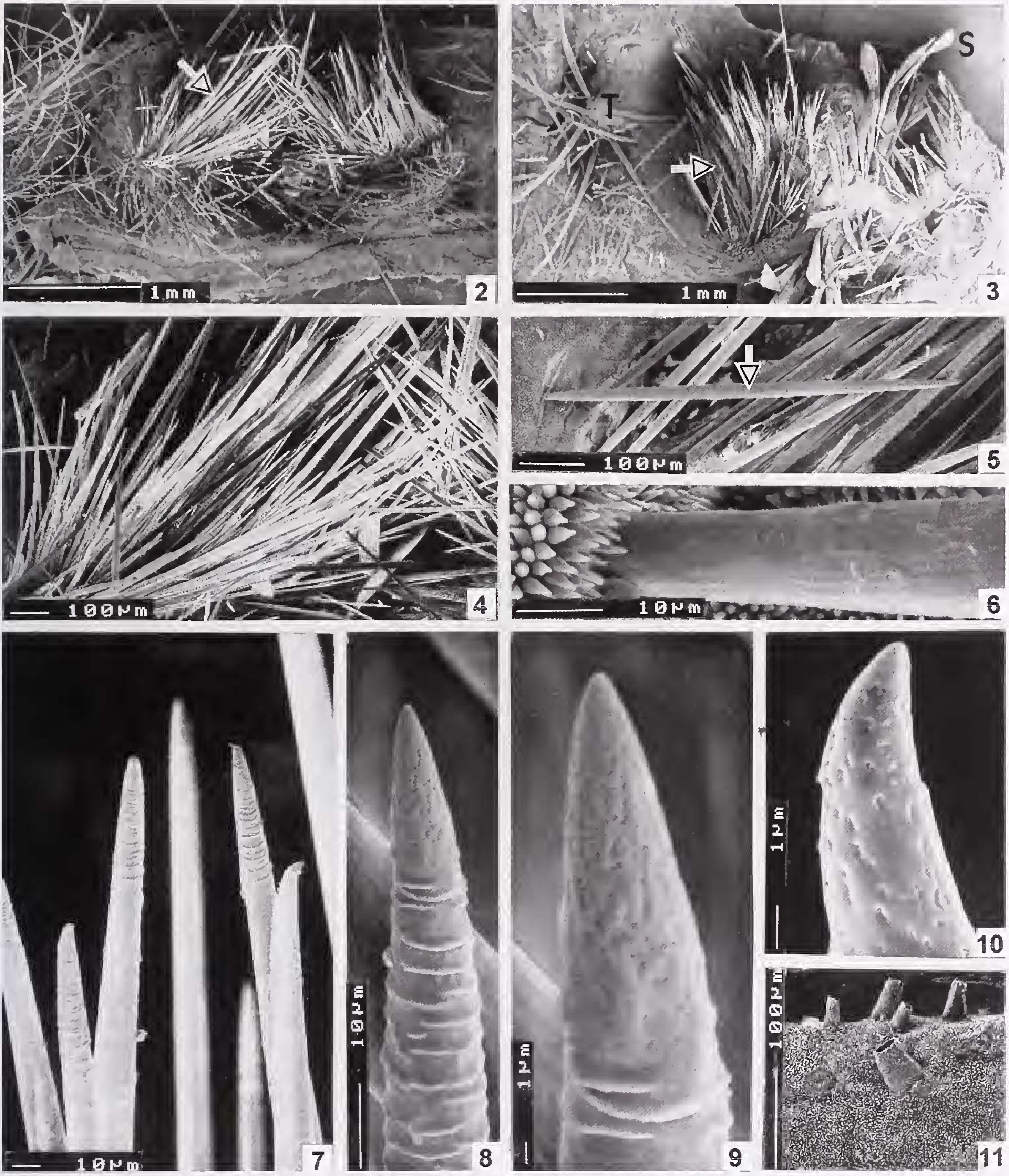
Fig. 1. Larva of *Streblote panda*, last instar. Left: at rest, right: disturbed, showing the two urticating crevices.

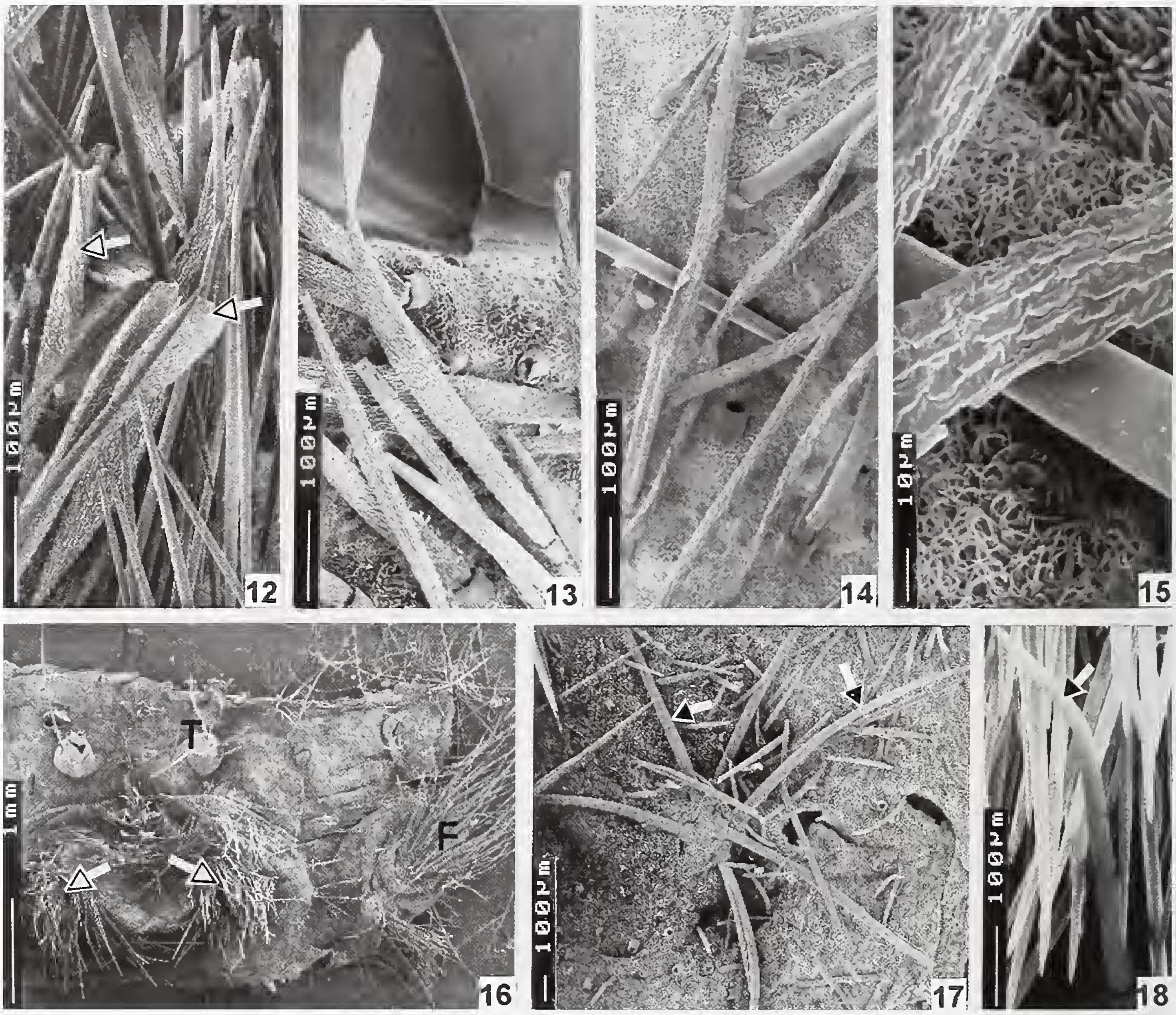
ated longitudinally from the base onwards over 14/15[th] of its length (Fig. 7). The distal part (1/15[th]) comprises an area with annular ligaments (Figs. 7, 8), tapering to the pointed and perforated tip (Figs. 9, 10). The estimated number of pores per hair is about 400; their diameter reaches 0.3 µm. The hairs are inserted in raised cupolae, from which they may be detached (Fig. 11).

Different types of integumentary structures are associated with the urticating apparatus:

- Some thirty white scales, 0.30–0.35 mm long, are lined up along the posterior edge of each urticating pocket (Fig. 12), whereas dark scales are spread over the rest of the segment (Figs. 13, 14). The white scales, which have the form of a strongly elongated tennis racket (some visible in fig. 3), are covered with longitudinal ribs made up of overlapping elements resembling roof tiles (Fig. 15). This structure is analogous to that of scales found on butterflies' wings.
- Five–six nonporous sensilla chaetica, 0.90–1.15 mm long, are found on the pair of white D1 verrucae in the anterior area of the meso- and metathorax (Figs. 16, 17). Other sensilla chaetica, 0.50 mm long, are found among the urticating hairs (Fig. 18).
- Sensilla filiformia, 1.5–2.0 mm long, are found in lateral tufts on the meso- and metathorax (Fig. 16).



Figs 2–11. Urticating apparatus of *S. panda*. **2**. Urticating crevice on the mesothorax, showing urticating hairs (arrow). **3**. Setal tubercle (T), urticating hairs (arrow) and scales (S). **4**. Group of urticating hairs. **5–11**. Urticating hairs. **5**. Entire hair (arrow). **6**. Base of hair. **7**. Tips of hairs. **8**. Tip of hair with ringed and perforated area. **9**. Detail of the perforated area. **10**. Detail of distal pores. **11**. Cupolae of urticating hairs.



Figs 12–18. Scales, tubercles, sensilla and urticating hairs of *S. panda*. **12**. Scales (arrow) among urticating hairs. **13**. Isolated scales. **14.** Filiform scales. **15.** Detail of scales. **16**. Dorsal surface of the metathoracic segment showing two setal tubercles (T), urticating hairs (arrows) and filiform sensilla (F). **17**. Setal tubercle with sensilla chaetica (arrows). **18**. Sensillum chaeticum (arrow) among the urticating hairs.

DISCUSSION

Structure. The large number of urticating hairs is characteristic of urticating apparatuses (Bourgogne 1951). Unlike ordinary long hairs, the urticating hairs of lepidopteran larvae are typically not arranged at random and do not cover the caterpillars' bodies in a uniform manner. They are arranged in very dense groups on well defined surfaces known as 'mirrors' that are integumentary folds (Sellier et al. 1975) or other specific surface areas. The first larval instars lack urticating hairs. In the 5th larval instar of the 'brown-tail moth' *Euproctis chrysorrhoea* (Linnaeus) (Lymantriinae), the 'pine procession moth' *Thaumetopoea pityocampa* (Denis & Schiffermüller), and the 'oak procession moth' *Thaumetopoea processionea* (Linnaeus) (Thaumetopoeinae), these mirrors are located on abdominal segments I–VIII whereas in the 3rd instar of the same species, they appear on different segments (Sellier et al. 1975). This difference in location of defense-related setae among instars is rather unusual, given that in most groups, as in *S. panda*, the position is constant throughout the larval development. After they appear in the 2nd instar (according to Calvo & Molina 2008), they remain on the same thoracic segments, a situation known from many other species of Lasiocampidae (e.g., in the genera *Dendrolimus* and *Gastropacha)*. Other lasiocampid moths, such as *Macrothylacia rubi*, *Lasiocampa quercus* and others, are known to possess urticating hairs on the abdominal segments (Carter & Hargreaves 1988).

A single type of urticating hairs is known in *S. panda*. This is also the case in most other species of different families (Gilmer 1923, 1925; Faucheux 2007). However, there are also species that have several different types of hairs, e.g. three types in *Latoia thamia* Rungs (Limacodidae) (Faucheux 2000). Among the different forms of urticating hairs, the most frequent in lepidopteran caterpillars is a harpoon-shaped hair with pointed spikes directed towards its distal end and arranged in three or four longitudinal rows, e.g. as in *T. pityocampa, T. processionea, E. chrysorrhoea* (Sellier et al. 1975), *Lithosia quadra* Linnaeus (Faucheux 2007), and in one type of *L. thamia* (Faucheux 2000). These hairs, though hollow, are not perforated at any extremity and therefore are unable to inject the toxic substance (Sellier et al. 1975). Instead, they must be broken, for example in the skin, in order to release their urticating substance (Ducombs et al. 1979).

In another type of hair, the nucleus of the poison-gland cells is located at the base of the hair and the cells develop inside the hair. During contact, the urticating substance is released as the acute, sharp end of the hair breaks. This type has been described in the "urticating thorns" of *Latoia* (= *Parasa*) *hilarata* Staud. (Mills 1925) and in the "poison apparatus" of *Latoia* (= *Parasa*) *latistriga* Walker (Gilmer 1925). Gilmer (1923) distinguishes two types of poisonous apparatuses of which the one he considers more primitive consists of simple hairs that are shorter and stiffer than others; each hair is connected through its proximal end to a poison gland and opens in a distal pore (e.g., *Orgyia leucostigma* (J. E. Smith)). The structure of the urticating hairs of *S. panda* may therefore be close to this primitive type, as the irritating substance flows through the numerous pores located on the distal end of the hair.

Function of the mirrors. The mechanism for opening and closing the 'mirrors' (or crevices) that contain the urticating hairs was described for *T. pityocampa* by Demolin (1963). In this species, the implantation zone of the hairs is delimited by a semi-rigid frame made up of chitinous rods and small pads forming hinges. This arrangement can open or close the insertion zones of the hairs that are normally hidden. When the caterpillars feel threatened, this mechanism opens the fold and the urticating hairs become entirely exposed. In *S. panda*, the opening mechanism has not been studied in detail, but may function in a similar way.

Urticating function. The urticating, harpoon-shaped hairs of the 'brown-tail moth', the 'pine procession moth', and the 'oak procession moth' can penetrate skin and eyes, and cause irritating cutaneous eruptions or contact dermatitis and ocular lesions (Blair 1979, Ducombs et al. 1979). Their urticating properties last for a very long time, sometimes up to several months after their ejection (Ducombs et al. 1979). In these species, the combination of a mechanical element (penetration of the skin and breaking of the hairs caused by scratching) and a chemical element (discharge of a toxic substance derived from dermal glands) account for the pathological symptoms. The action of the urticating hairs is ascribable, at least in part, to the secretion of histamine that takes place on the skin as a result of the penetration of the poison contained in the hairs (Leclercq 1977).

In *S. panda*, urticating hairs are released in large numbers when the caterpillar is handled. In contact with the skin, they stick to it by means of their distal circular ligaments, but the urticating effect seems to be low. The numerous pores at the distal ends of the hairs indicate that a liquid is being released, but direct evidence is still missing. Previous studies do not mention strong irritations or even dermatitis caused by the caterpillars of the lappet moth.

Protective function. The aposematic red and dark brown of the two urticating crevices strongly contrast with the overall grey colour of the larva. Unlike other urticating caterpillars, those of *S. panda* undoubtedly use their urticating apparatus mainly as a means of warning against their predators. To my knowledge, no study has tested the efficacy of this defence mechanism against natural enemies. In the environment in which I observed the Moroccan caterpillars (colonies of *Retama* sp.), they come in frequent contact with likely predators such as the common chameleon, *Chamaeleo chamaeleon* Linnaeus and the stripeless treefrog, *Hyla meridionalis* Boettger, which may hesitate to prey on the caterpillars. Similarly, children and adults are unwilling to touch a caterpillar that manifests its anxiety by opening and closing its hair slits.

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